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Nanoscale organization of the normal human dermal fibroblasts and mesenchymal stem cells isolated from adipose tissue

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Stem cells are an immature cells which are the source of a large number of other cell types. It is well known that they are classified as embryonic stem cells, pluripotent stem cells and adult stem cells. The most important population of adult stem cells are mesenchymal stem cells (MSC). At first, these cells were detected and isolated from the bone marrow. It was believed that the bone marrow-derived mesenchymal stem cells are a source for updating and restoring such connective tissues like bone, skin, cartilage and fat. Nowadays, bone marrow MSCs analogues are detected in all other tissues. In this work we summarize our data concerning nanoscale organization of human mesenchymal stem cells and dermal fibroblasts to study their potential role in the regeneration and transplant processes.

Skin biopsies were obtained during mammoplasty surgery with *p*atient-informed consent. Tissue fragments (explants) were placed in plastic petri dishes with addition specific nutrient medium. The medium was replaced every 3-4 days. The cells were harvested when grown to 80% confluence and dispersed in a new plastic culture bottles. Mesenchymal stem cells were obtained from human adipose tissue according to protocol S. Schneider et al., 2017 [1]. AFM images were obtained in tapping mode using silicon cantilevers with a resonant frequency of 190-315 kHz. All measurements were performed at room temperature.

AFM analysis revealed variations in structural organization of the analyzed cell types. Dermal fibroblasts (the average sizes – 15-20 μm) (fig. 1a) exhibited a very distinguishable actin cytoskeleton organization – a lot of cross-linking actin filaments and larger fibers (like stress fibers) in filopodia. Conversely, MSCs (fig.1a) exhibited a smooth surface and almost no stress fibers but had a very large variation in size that exceeded 60-70 μm.

To characterize the elasticity of these cells, mean Young's modules were calculated. The results reveal that there are significant differences between the fibroblasts-like cells (Young's modulus) collected from human skin (value – 1.4-7.8 kPa) than human adipose tissue (value – 5.2-6.4 kPa). This is probably due to a large variety of cells of the surface epithelium, which are highly specialized and occupy certain tissues niches.

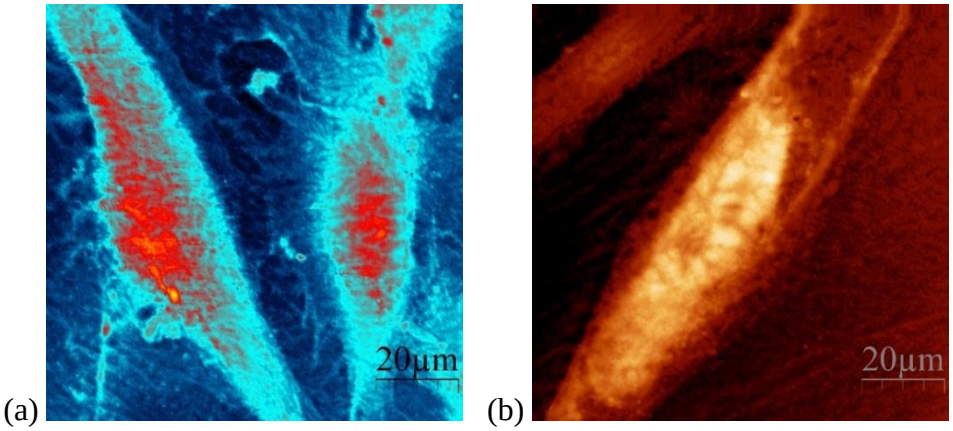

Figure 1. Typical surface topography of the analyzed cell types. AFM tapping-mode images of (a) human dermal fibroblasts and (b) mesenchymal stem cells.

In summary, our study showed morphometric and biophysical features of dermal fibroblasts and mesenchymal stem cells. We improved understanding of the physical characteristics of different cell types. The obtained results can be used to understand their general biological significance and to search for their specific potential and other properties in regenerative medicine and transplantology.

1. S. Schneider et al. *Eur. J. Med. Res.* **22**, 17 (2017).